The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-92

Anonymous Referee #1

Referee comment on "Impacts of the photo-driven post-depositional processing on snow nitrate and its isotopes at Summit, Greenland: a model-based study" by Zhuang Jiang et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-92-RC1, 2021

In this study, the authors carried out a model study, trying to reveal the post-depositional processes of snow nitrate and isotopes at Summit, Greenland. This study addressed the question for the snow nitrate regarding the ice core study and in the scope of *The Cryosphere*.

The model was proposed by Erbland et al. (2015) and has been applied for the investigation of the post-depositional process of snow nitrate in Antarctica. The field data used in the model was taken from the previous studies. The present study demonstrated the significant redistribution of nitrate in the upper snowpack due to the photolysis in the high accumulation site. In addition, the effects of the post-depositional process on the isotopes ($\delta^{15}N$ and $\Delta^{17}O$) were investigated in a quantitative way. Thus, the present study has novelty and impact to be published in this journal after revising.

The methods were clearly written and suitable for this study. However, some assumptions in the model were not discussed, such as the effect of the wavelength, the wind blowing, the temperature, and the evaporation as mentioned in the specific comments. In addition, there is a lack of evaluation of the present study comparing to the previous model studies as mentioned in the specific comments.

Specific comments

Line 60-63: This sentence was supported by field observations (Erbland et al. 2013; Noro et al. 2018).

Line 95-96: The e-folding depth depends on the wavelength (Noro and Takenaka 2020). How did you obtain the e-folding depth of each wavelength from 280-350 nm?

Line191-192: Mean values of the accumulation data were used to avoid the negative values induced by the wind blowing in the present study. However, Pham et al. (2019) demonstrated that the wind blowing dominates the removal of the photodegradable organic contaminants from the surface snow in Antarctica (Pham et al. 2019). Therefore, the effect of the wind blowing should be discussed (I do not mean that authors have to conduct the model study which includes the wind blowing.).

Line 238: Jarvis et al. (2009) reported the surface snow $\delta^{15}N$ (NO_3^-) only for 5 months (March to July). How did you obtain the annual data? In addition, if you have each data point of Jarvis et al. (2009), please indicate in the same manner as observation (plots and lines) in Fig. 1.

Line 274-275: please add citations for the wavelength dependent of ε_p.

Line 274-275: Does this sentence means that the wavelength change in season affects the ε_p, resulting in the peak of the FP ($\delta^{15}N$) in mid-summer? In this case, please show the data for the wavelength change.

Fig. 2: Please explain why the FD ($\delta^{15}N$) is changing.

In regard to evaporation/volatilization: The effect of evaporation was neglected in the present study. Shi et al. (2019) demonstrated that 38% of nitrate was lost from the snow sample at −4â□□ for 14–16 days (Shi et al. 2019). Moreover, the temperature of the surface snow is closed to 0â□□ in the daytime in summer in the Antarctic coastal site (Noro et al. 2020). Thus, the potential impacts of evaporation should be discussed in the present study.

In regard to the positioning of the model compared to the previous studies:

The model studies have been reported, related to the post-depositional process of nitrate in Greenland (e.g. Zatko et al. 2016). The advantages and the disadvantages of the models proposed in the previous studies and the present study should be described to demonstrate the positioning of the present study as a paragraph in the Introduction or as a section in the Results and discussion.

Technical corrections

Line 20 and any other pars: Space is not needed before “%” and “‰”.

Line 32 and many other parts: "Minus" should not be indicated as "-" but "−".

Line 110: J(NO$_2$)☐$J_{(NO2)}$

Line 215: won't☐will not

Line 279: ware null☐were negligible

Fig. 3: Please spell out F_{pri} in the caption.

Fig. 3: Remove the frame border of the legend.

Erbland J, Vicars WC, Savarino J, Morin S, Frey MM, Frosini D, Vince E, Martins JMF. 2013. Air–snow transfer of nitrate on the east antarctic plateau – part 1: Isotopic evidence for a photolytically driven dynamic equilibrium in summer. Atmos Chem Phys. 13(13):6403-6419. 10.5194/acp-13-6403-2013

Noro K, Hattori S, Uemura R, Fukui K, Hirabayashi M, Kawamura K, Motoyama H, Takenaka N, Yoshida N. 2018. Spatial variation of isotopic compositions of snowpack nitrate related to post-depositional processes in eastern dronning maud land, east antarctica. Geochem J. 52(2):e7-e14. 10.2343/geochemj.2.0519

Noro K, Takenaka N. 2020. Post-depositional loss of nitrate and chloride in antarctic snow by photolysis and sublimation: A field investigation. Polar Res. 39. 10.33265/polar.v39.5146

Pham OK, Noro K, Nabeshima Y, Taniguchi T, Fujii Y, Arai M, Sakurai T, Kawamura K, Motoyama H, Thi HTO et al. 2019. Concentrations of polycyclic aromatic hydrocarbons in antarctic snow polluted by research activities using snow mobiles and diesel electric generators. Bulletin of Glaciological Research. 37:23-30. 10.5331/bgr.19A02

Shi G, Chai J, Zhu Z, Hu Z, Chen Z, Yu J, Ma T, Ma H, An C, Jiang S et al. 2019. Isotope fractionation of nitrate during volatilization in snow: A field investigation in antarctica. Geophys Res Lett. 46(6):3287-3297. 10.1029/2019GL081968

Zatko M, Geng L, Alexander B, Sofen E, Klein K. 2016. The impact of snow nitrate photolysis on boundary layer chemistry and the recycling and redistribution of reactive nitrogen across antarctica and greenland in a global chemical transport model. Atmos Chem Phys. 16(5):2819-2842. 10.5194/acp-16-2819-2016